

Ocean Research Report

EXPEDITION #16
r/v Regina Maris
Juneau - Ketchikan

6 August - 9 September 1979



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and Education Society, Inc.
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KRILL AVAILABILITY AND THE DISTRIBUTION OF HUMPBACK WHALES
IN SOUTHEASTERN ALASKA

Cruise Report of
r/v REGINA MARIS EXPEDITION #16
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This manuscript was submitted to SCIENCE Magazine.

ABSTRACT

The number of humpback whales using Glacier Bay, Alaska, as a summer feeding ground has decreased drastically in the last few years, and it has been claimed that this is due to increased cruise ship traffic. Large numbers of whales still spend the summer in Frederick Sound and other areas of Southeast Alaska. Measurements of the density of krill at various locations showed that this major food source was over twenty times as abundant in Frederick Sound as in Glacier Bay. Thus, the lack of food may be the reason for the abandonment of Glacier Bay by the humpback whale.

The humpback whale (Megaptera novaeangliae) undergoes a remarkable migration each year between tropical breeding areas and feeding grounds nearer the poles¹. At least some members of the breeding populations observed each winter in Hawaii and off the west coast of Mexico migrate to Southeastern Alaska for feeding in the summer, according to recent studies using tailfluke photography². Stomach contents of whales taken by the Japanese whaling industry in the North Pacific³ show that the main food of humpback whales in these waters is krill, the name applied to several species of euphausiid crustaceans which are less than an inch long but exist in vast numbers in the plankton, especially during summer⁴. Humpbacks also feed on several types of schooling fish, including capelin, sardines, cod, herring, and atka mackerel³.

Some species of euphausiid are known to exhibit swarming behavior, but the extent to which this is true of the North Pacific species remains to be determined. Such swarming behavior, as well as the schooling of fish, makes it easier to understand how baleen whales such as the humpback can obtain a sufficient mass of food from these small animals. Humpbacks and other rorquals generally appear to take their food by "gulping" in which a single mouthful of water, taken in with the throat expanded, is expelled through the filtering fringes of the baleen⁵. This feeding method distinguishes them from right whales and the sei whale which take their food by "skimming," filtering the water more or less continuously as they swim through it.⁵

An intriguing type of feeding behavior which is apparently restricted to the humpback whale is "bubble-netting," described originally by Ingebrigtsen⁶ and studied more recently by the Jurasz⁷, Earle⁸ and Payne⁹. In this maneuver, the whale locates a body of feed and dives about fifty feet

below it. It then discharges a stream of bubbles through the blowhole while swimming to the surface in a helical path. The cylindrical curtain of bubbles thus formed concentrates the prey in the center, and the whale finally gulps the concentrated feed near the surface. During bubble-netting the fish or krill can be seen in dense concentrations at the surface in the center of the net⁷, and dipnet sampling within bubble nets suggests that the behavior is, indeed, effective in concentrating krill⁸.

Of about sixty humpback whales which feed in Southeastern Alaska each year, approximately twenty are usually found in Glacier Bay⁷. Usually some of these arrive in early June and the remainder in late June or early July¹⁰. However, in the 1979 season only about six whales arrived in early June and soon left the area, and of some 6-12 animals which were present at the bay mouth at a time appropriate for the second influx only 3-5 remained¹⁰. As in previous years, a relatively large concentration of whales was observed to the south in the Frederick Sound area. One possible reason for the scarcity of humpbacks in Glacier Bay this year is increased vessel traffic; 123 cruise ship visits were scheduled for the bay this summer.

In order to try to understand the factors controlling the distribution of humpback whales in their feeding grounds we undertook a series of vertical plankton tows aboard the R/V Regina Maris in Southeastern Alaska in August 1979. At the same time, a constant daylight watch for humpback whales was maintained, and the locations & numbers of animals for each sighting plotted on the chart.

We observed only three whales in Glacier Bay, but the density of animals in Frederick Sound was so high as to preclude an accurate count by our methods.

However, the estimate of the relative numbers in the two areas can be obtained by comparing the number of whales sighted per day, efforts having been made to avoid repeat sightings of the same animals. The average number of whales sighted per day is then 2.5 for Glacier Bay and 19.0 for Frederick Sound; about an eight-fold difference.

For the plankton tows, two 62 cm bongo nets, mesh 0.333 mm and 0.505 mm, were hauled upwards through the top 200 m of water (hauling speed 40 m/min) or the top 150 m, 133 m or 100 m where the water was too shallow for the standard tow¹¹. Some euphausiids are known to migrate to greater depths than these during the day in the open ocean⁴ but Euphausia pacifica occurs mainly above 300 m, Thysanoessa spinifera mainly above 100 m and T. longipes mainly between 140 and 280 m⁴. Furthermore, in the one fjord which has been studied, E. pacifica was restricted to the top 100 m¹². The depth to which humpback whales dive during feeding is not known, but this must at times be limited by the water depth since they are often observed feeding in relatively shallow areas.

The species of krill found in our samples were Euphausia pacifica, Thysanoessa spinifera, and occasional specimens of T. longipes¹³. These are among the species commonly found in inshore waters of Southeastern Alaska¹⁴ and in the stomachs of humpback whales taken in the North Pacific⁵.

All of the krill in our samples were counted and the total number (all species) per 100 m³ of filtered water determined. The results are shown in Fig. 1. We found very high concentrations of krill at three out of five stations in central Frederick Sound, an area where large numbers of whales were frequently sighted. In west Frederick Sound a high concentration was found at station 18 at a time when whales surrounded the ship, but three hours later at nearby station

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19 after whales had left the area, a low krill count was obtained. At stations 14 and 21 high krill counts were associated with the presence of whales, whereas in the southeast arm of Frederick Sound (station 17) and the northern part of Sumner Strait (station 26) the krill count was very low and no whales were seen. In Chatham Strait the krill counts ranged from very low to very high and whales were seen especially in the southern part of the strait, whereas in Stephens Passage a similar range of krill counts was encountered in the absence of whales.

The most striking feature of our data is the extremely low krill counts in samples from all five stations in Glacier Bay and the one in Icy Strait. These stations gave an average of 20.4 krill/100 m³ whereas the ten stations in Frederick Sound gave an average of 477 krill/100 m³, a twenty-three fold difference. Thus, the possibility arises that a relative lack of feed was an important factor limiting the use of Glacier Bay by humpback whales in the 1979 season.

Plankton samples in general, and euphausiid counts especially, are notoriously unreliable because of variation in technique, horizontal and vertical patchiness and diurnal vertical migrations of the animals⁴. A likely source of variation in our data is vertical migration, but the one Frederick Sound sample taken at night (station 16) gave an unusually low krill count for that area, contrary to the expected higher count. This suggests that krill patchiness may be an even greater source of variation in the data than is vertical migration. In fact, it would seem that the krill sampled in our nets would have to be concentrated in narrow layers to be a worthwhile source of food for whales. Indeed, krill counts of up to 250/m³ have been reported when sampling has been done at specific depths¹⁵, and E. pacifica has been observed in surface swarms

12 after whales had left the area, a low krill count was obtained. At stations 14 and 15 high krill counts were associated with the presence of whales, whereas in the southeast arm of Frederick Sound (station 17) and the northern part of Summer Strait (station 20) the krill count was very low and no whales were seen. In Chatham Strait the krill counts ranged from very low to very high and whales were seen especially in the southern part of the strait, whereas in Stephens Passage a similar range of krill counts was encountered in the absence of whales.

The most striking feature of our data is the extremely low krill counts in samples from all five stations in Glacier Bay and the one in Icy Strait. These stations gave an average of $30.4 \text{ krill}/100 \text{ m}^3$ whereas the ten stations in Frederick Sound gave an average of $677 \text{ krill}/100 \text{ m}^3$, a twenty-three fold difference. Thus, the possibility arises that a relative lack of food was an important factor limiting the use of Glacier Bay by humpback whales in the 1979 season.

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off Japan¹⁶. However, it is difficult to see how either vertical migration or patchiness could explain the more than twentyfold difference which we found in krill counts between Glacier Bay and Frederick Sound.

The correlation we have observed between krill availability and whale distribution is similar to that reported by Hardy for Euphausia superba with blue and fin whales off the island of South Georgia¹⁷. Whether these whales find their prey by random searching, or whether they have some way of sensing them at a distance, is not known. Euphausiids are often the cause of the "deep scattering layer" seen on depth sounders¹⁸, so it is theoretically possible for whales to detect them over a short distance by echolocation, especially if they form dense swarms. Preliminary experiments, however, indicate that humpback whales do not echolocate¹⁹.

The factors governing krill abundance are poorly understood, although it is known that they flourish in areas of deep-water upwelling, as do other planktonic organisms. In Glacier Bay the climatic conditions are also likely to be important to the extent that they change the rate of glacier melting and calving, with consequent effects on the salinity and turbidity of the waters. A detailed study of the distribution of the organisms which constitute the food of euphausiids would help to resolve this question²⁰.

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20. This is Publication No. 8 of the Ocean Research and Education Society, Inc. We thank the crew and students of the R/V Regina Maris for their patience and assistance during the course of this study.

Figure Legend

Figure 1. Krill densities and humpback whale sightings from R/V Regina Maris in southeastern Alaska during August 1979. Circles are drawn so that their areas are proportional to krill densities determined from vertical plankton tows at 29 stations (numbered A-C and 1-26). Humpback whale observations are recorded as separate "sightings" where each sighting may consist of a number of animals but these animals are separate from those of other sightings as far as this can be determined. We are, however, unable to avoid overlap between sightings on separate days and so this map gives an approximate picture of the distribution pattern rather than an accurate census.



